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VNUTRIVIDOVAYA STRUKTURA I PRINTSIPY PROGNOZIROVANIYA GORBUSHI SAKHALINO-KURIL'SKOGO BASSAEINA

THE INTRASPECIFIC STRUCTURE AND PRINCIPLES OF PINK SALMON FORECASTING IN THE SAKHALIN-KURIL BASSIN

By V.N. Efanov

The three hundred main spawning rivers of Sakhalin, with an area equal approximately to 24 million square meters, are the reproduction grounds of a number of pink salmon communities having a complex intraspecific structure. Lines of even-year and odd-year generations probably must be considered as the most significant level of ecological differentiation. The existence of individual populations of this level is the result of the two-year life expectancy of pink salmon, something that was shown both in the study of biochemical polymorphism of proteins (Aspinwall, 1973; Altukhov and others, 1980) and during karyological analyses of pink salmon specimens belonging to contiguous generations (Gorshkova, Gorshkov, 1983). Thus, in odd-year generation lines specimens having the karyotype $2_p = 53.54$ prevail, whereas among the even-year specimens of pink salmon there are considerably more with $2_p = 52$ without acrocentric chromosomes.

Let us now turn our attention to the problem of differentiation at the level of early and late migrating populations, which are known with reference to other species of fish as summer and autumn races. Identifying such populations is more difficult than identifying generations of different years, and it is necessary to conduct special biological and statistical studies. In particular, we analyzed the information on the second catches of pink salmon tagged in the Sea of Japan, the Pacific Ocean and the southeastern part of of the Tatar Strait (Tab. 1). As may be seen from the table, pink salmon come to the western coast of Sakhalin only

from the first foraging region, while other coasts are approached from the first and second foraging areas (Fig. 1). At the start of the run, i.e. in June and July, migrants from the first foraging area prevail in the fishing sectors, whereas in August and September those from the second area are more numerous.

One can judge of the migration of two groups of pink salmon to the various sectors of the Sakhalin-Kuril region from the intensity of their run at the coast, as is shown by the average catch with stationary fishing gear (trap nets). As an example, we shall examine the data for 1979 shown in Fig. 2 as daily catch curves expressed in percent of the total catch. As may be seen, each one of the curves is bimodal, agreeing with /2 the bimodal character observed in the dynamics of male-female ratio in the catches.

Thus, in the coastal waters of the Sakhalin-Kuril basin (except at the western coast of Sakhalin) one may see runs of two groups of specimens - early and late - which have been foraging in different places.

The question arises whether the specimens of each run are genetically of a different quality. To provide an answer to this question, we collected samples of muscles and liver of pink salmon and determined the frequency of occurrence of phenotypes MDN and alleles of loci AGP, PGD and PGM from various localities. The data obtained were grouped according to dates in agreement with the dynamics of salmon run at the coast.

This has allowed us to establish that the differences between the the first and second group of samples were not large bu statistically reliable and to classify the first group as summer and the second as fall.

It has been established in subsequent studies that specimens of the summer group spawn in the upper course of rivers and their affluents, and those of the fall group at the spawing grounds of the middle and lower course.

Taking into account the above differences between specimens of two communities, and also considering T. Dobzhanskii's definition of population, (1955, 1970), we came to the conclusion that specimens of two pink salmon populations - summer and fall - reproduce in the rivers of the Sakhalin-

Kuril region.

Next, we turned our attention to subdivisions within the populations themselves. Studies of the biological indexes of pink salmon from different localities resulted in the isolation of the following groupings within the summer population: western Sakhalin, Gulf of Aniva, southeastern coast, Gulf of Terpenie, northeastern coast, and the Iturup Island. As far as the fishes of the fall population are concerned, they can be subdivided in almost the same way(with the exception of the western coast of Sakhalin, from which they are absent, and the Kunashir Island and the Urup Island, where they are present).

Each of the above-mentioned groupings that we call subpopulations is /3 associated with territorial complexes having specific characteristics among the bodies of water where the fish reproduce (the hydrological regimen of rivers, the quality of spawning grounds), coastal sectors of the sea (food supply, thermal regimen) and climatic conditions that indirectly or directly affect the salmon's level of reproduction.

Let us now trace the fluctuations in the numbers of each of the intraspecific substructures.

An analysis of the changes in the absolute number of pink salmon reproducing in the rivers of the Sakhalin region in 1970-1987 revealed that the even-year generations fluctuated less than the odd-year generations. We believe that this depends on the differences in the ratio of the numbers of these populations between groupings of the lower hierarchic level - the summer and the autumn populations. At the same time, the largest absolute numbers are observed in those generations when the ratio between the size of the summer and the autumn population approximately corresponds to the share of their spawning potential in each of the local sectors.

The existing differences in the level of fluctuations in the numbers of fish in the summer and autumn groupings are explained by the fact that specimens of the former spawn in the upper and middle course of rivers in late July and the first twenty days of August, less frequently until the first days of September, and those of the second grouping spawn in the middle and lower course from the end of the second or the beginning of the

fourth five-day period of August to the end of September and, in some years, until October. That means that there exists an isolation in time and biotope between the fishes of these populations, and the development of their eggs and larvae, even if they spawn in the system of the same river, takes place under different environmental conditions, which leaves its imprint on the effectiveness of reproduction.

Like the preceding ones, the communities of the third level in the population structure of pink salmon (subpopulations or local populations), the specimens of which are associated with certain territorial complexes, are characterized by differences in the effectiveness of reproduction. The latter, as a rule, diminishes further north and is the highest in the populations inhabiting the territorial complexes with the most favorable environmental conditions, especially during the fluvial period of their lives, namely where the water regimen is stable. As an example of a community with a high effectiveness of reproduction we may quote the subpopulation of the autumn population of pink salmon at the Iturup island. Due to the climatic characteristics of this region, namely large amounts of precipitation - 1400mm annually on the average - limited variations in air temperature throughout the year and low evaporation of water, the conditions for spawning and the emryonic-larval development as a whole are favorable at the island, as proved by a comparatively high coefficient of downstream migration of young fish, on the average equal to 27.2% of the fertility potential. The environmental conditions at the north-eastern coast of Sakhalin are more severe and, as a result, the coefficient of downstream migration of the "autumn" subpopulation in this sector is lower, viz. 19.6%. /4

Thus, pink salmon, like other salmon species, have a complex population structure, and the fluctuations in the number of their spatial levels have characteristics of their own due to differences in the ecology during the reproduction of each of the intraspecific substructures. Consequently, in the control of reproductien and a rational exploitation of pink salmon reserves, one must take into account their complex spatial structure and set the quotas of catch not by region but according to the effectiveness of reproductien of each local populatien, adjusting the intensity of fishing

in each season to the size of the reserve stock, achieving at the same time the optimal exploitation of the spawning potential of the entire river system.

The share of the second catch of pink salmon (in percent) migrating from the first (upper row) and second (lower row) feeding and growing areas in the main fishing regions of the province of Sakhalin

Table 1

Таблица I.

Доля вторичной поимки горбуши (в процентах) мигрирующего из первого (числитель) и второго (знаменатель) районов нагула в основных районах промысла сахалинской области

Place of second catch	May	June			July			August			September	
Место вторичной поимки	май	июнь			июль			августа			сентябрь	
	II	I	II	III	I	II	III	I	II	III	I	II
Southwestern coast of Sakhalin (foraging sector)	100 / 0	100 / 0	100 / 0	100 / 0	100 / 0	100 / 0	100 / 0					
Western coast of Sakhalin (prespawning sector)			100 / 0	100 / 0	100 / 0	100 / 0	100 / 0	100 / 0				
Gulf of Aniva (prespawning sector)			100 / 0	100 / 0	100 / 0	100 / 0	70 / 30	75 / 25	50 / 50	40 / 60	0 / 100	0 / 100
Southeastern coast of Sakhalin (prespawning sector)					100 / 0	100 / 0	67 / 33	50 / 50	0 / 100	0 / 100	0 / 100	0 / 100
Iturup Island						100 / 0	67 / 33	50 / 50	100 / 0	100 / 0	100 / 0	100 / 0
Weighted mean (not counting the return to the southwestern and western coast)					100 / 0	87,5 / 12,5	76,5 / 23,5	61,5 / 38,5	8,3 / 91,7	5,1 / 54,9	0 / 100	0 / 100

Foraging areas and migration routes of pink salmon in the Sakhalin-Kuril basin

Места нагула и пути миграции горбуши Сахалино-Курильского бассейна

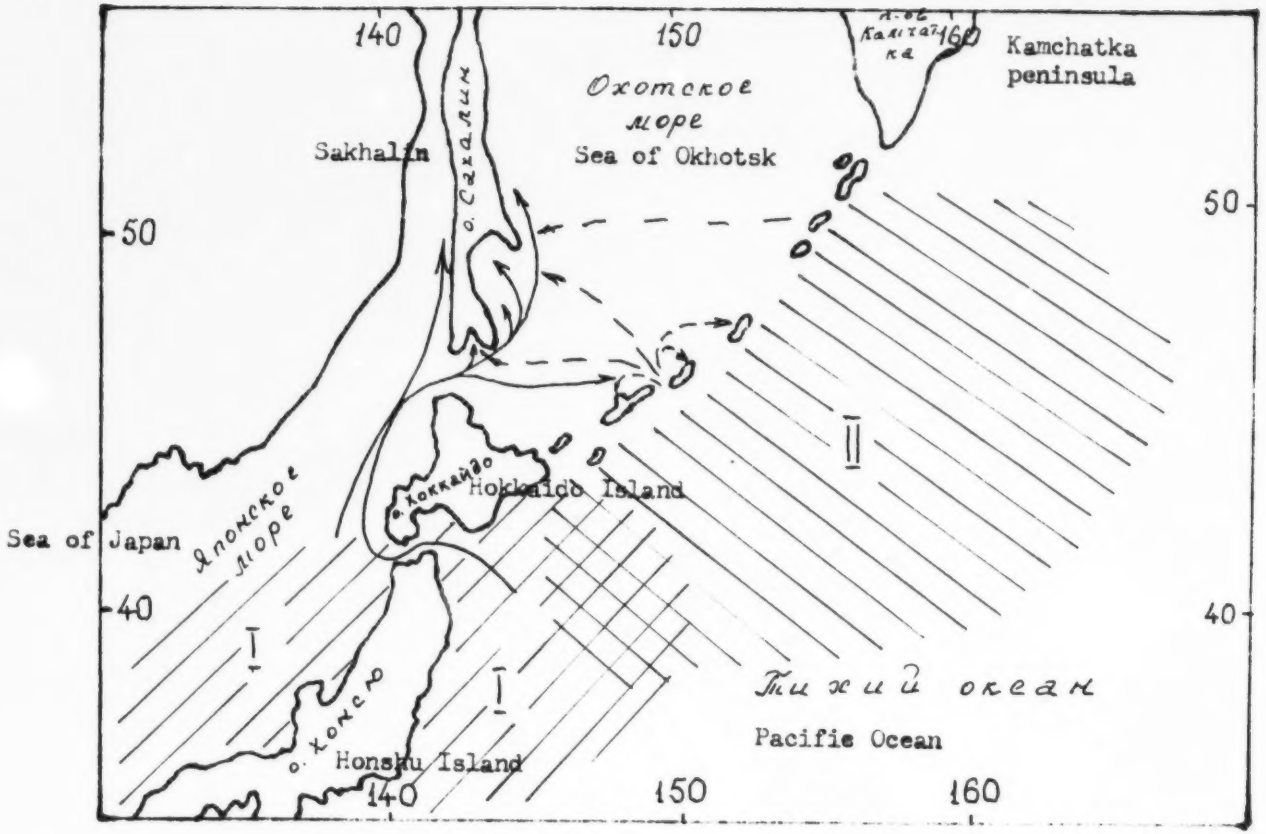

рис. 2.1

Figure 1

The dynamics of intensity of pink salmon runs
to various sectors of southern Sakhalin in 1979

Динамика интенсивности подхода горбуши
к различным участкам юга Сахалина
в 1979 г.

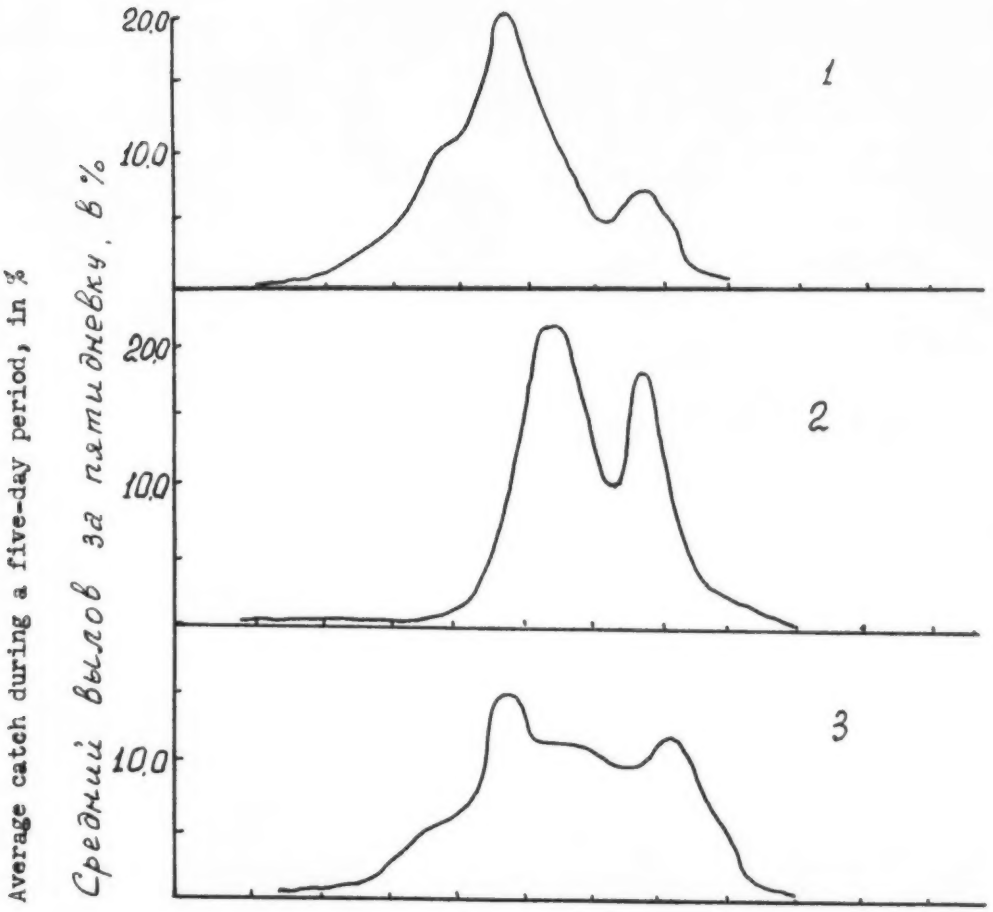

Figure 2

Рис. 8.2

1 - зал. Анива; 2 - зал. Терпения; 3 - ю-в. Сахалин.

1 - Gulf of Aniva; 2 - Gulf of Terpenie; 3 - Southeastern Sakhalin